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Inclusive Jet Cross Section Measurement at CDF

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(PRESENTED ON BEHALF OF THE CDF COLLABORATION)

The CDF Collaboration has measured the inclusive jet cross section using 1992-93 collider data at $\sqrt{s} = 1.8\,\mathrm{TeV}$. The CDF measurement is in very good agreement with NLO QCD predictions for transverse energies (E_{T}) below 200 GeV. However it is systemically higher than NLO QCD predictions for E_{T} above 200 GeV.

1 Jet Inclusive Cross Section

1.1 Introduction

The measurement of the inclusive jet cross section provides a conceptually simple, but fundamental test of QCD. This measurement has, at CDF, a very good statistical precision, typically a few percent, with relatively small experimental systematic errors, about 20-30% depending on the E_{T}. The NLO QCD calculations have small theoretical uncertainties [1] due to the choice of renormalization/factorization scale (μ). Within the framework of conventional QCD, the study of the jet inclusive cross section is also usefull to extract the strong coupling constant [2]. Jet production at the Tevatron is dominated by gluon-gluon scattering at low E_{T}. Whereas at high E_{T} the main contribution comes from quark-quark scattering.

1.2 Data Sample and Event Selection

At CDF [3] jets are recontructed using a fixed cone algorithm which is similar to the one used in the NLO theory. The cone size used in the present measurement is $R = 0.7$ where $\Delta R = \sqrt{\Delta\eta^2 + \Delta\phi^2}$. CDF collected $19.3\,pb^{-1}$ of data during the 1992-93 collider run. The measurement was performed using four different triggers with E_{T} thresholds of 20, 50, 70 and 100 GeV with pre-scale factors of 500, 20, 6 and 1 respectively. The data are corrected for the different trigger efficiencies. Events were required to pass the following selection criteria:

- $E_{\mathrm{T}} > 15$ GeV;
- At least one reconstructed vertex with $|z| < 60$ cm;

- Missing $E_{\rm T}$ significance: S $<$ 6 (S $\equiv \not\!\!E_{\rm T}/(\sum E_{\rm T})^{1/2}$);
- Negligible energy in the calorimeter out-of-time with the $p\overline{p}$ collision.

1.3 Corrections to the Jet Cross Section

Data are corrected for detector effects using an unsmearing procedure [4]. Detector effects include energy loss due to uninstrumented regions of the detector and the smearing effects due to the finite detector resolution. The measured $E_{\rm T}$ is parametrized as a function of $E_{\rm T}^{True}$. The $E_{\rm T}^{True}$ is defined as the sum $E_{\rm T}$ of all particles in a cone R around the jet direction. This parametrization is called *Response Function.* A very large sample of dijet events was generated and fragmented using the Feyman-Field fragmentation model, tuned to CDF data. This simulated sample was used to extract the response function. An hypothetical cross section as function of $E_{\rm T}$ is smeared by applying this response function and then fit to the data. The correspondence between smeared and unsmeared curves was used in order to derive the bin-by-bin corrections applied to the jet cross section distribution.

1.4 Results

The corrected cross-section is shown in Fig. 1.a compared to the NLO QCD predictions [1] using MRSD0' parton distribution function with a $\mu = E_{\rm T}/2$. There is very good agreement between the data and NLO QCD over seven orders of magnitude. However the data deviate from the theory predictions for $E_{\rm T}$ above 200 GeV.

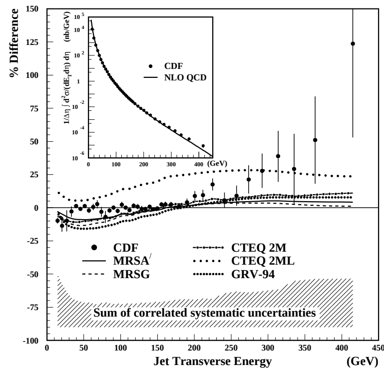
2 Systematic Uncertainties

The systematic errors have been evaluated by varying each of the sources of systematic uncertanty by $\pm\, 1\sigma$ and reappling the unsmearing procedure, Fig 1.b. No single source of systematic uncertainty can explain the excess of events at high $E_{\rm T}$ without destroying the agreement at low $E_{\rm T}$. Even allowing 3σ distortion does not provide a good agreement with QCD.

3 Possible Explanations of High $E_{\rm T}$ Excess

The possible explanations for this deviation include

- The choice of renormalization and factorization scale and PDFs;
- Corrections to the NLO QCD predictions, e.g. soft gluon resummation;



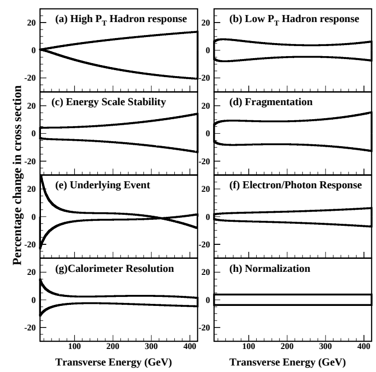


Figure 1: a) The inclusive Jet Cross Section with NLO QCD predictions evaluated with MRSD0' (*small figure*), comparison with other pdfs (*big figure*); b) The percentage change in the inclusive jet cross section when various sources of systematic uncertainties are changed by 1σ-standard deviation from the nominal values.

- Experimental systematics such as jet energy scale;
- New physics;

4 Conclusion

The inclusive cross section measured by CDF is in excellent agreement with NLO QCD below E_{T} of 200 GeV. Above 200 GeV the measured cross section begins to deviate from NLO predictions with an excess of 20-50% in the 260-360 GeV range. CDF observes a similar excess in the two-jet mass distribution and the ($\sum E_{\mathrm{T}}$) cross section. It is possible that the high E_{T} excess in these three measurements has a common explanation either as an experimental artifact or lack of theoretical understanding.

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